DOCUMENT RESUME

ED 170 688 CS 004 534

AUTHOR Beebe, Mona J.; Bulcock, Jeffrey W.
TITLE Cueing Strategies and Basic Skills in Early Reading.
PUB DATE Aug 78
NOTE 70p.; Paper presented at the Annual Meeting of the International Reading Association World Congress on Reading (7th, Hamburg, West Germany, August 1-3, 1978)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *Beginning Reading; Cognitive Development; Cognitive Processes; Comprehension; *Context Clues; *Cues; Elementary Education; Learning Theories; Reading Instruction; *Reading Processes; *Reading Research; Recall (Psychological)

ABSTRACT

The extent to which cuing strategies and basic skills explanations of early reading constitute complementary approaches was examined in a study involving 94 fourth grade students. Basic skills--a unidimensional component based on measures of vocabulary development, language skills, and work-study skills--proved to be a powerful variable mediating the effects of two relatively orthogonal exogenous cuing strategy variables (graphophonic cues and syntactic/semantic cues) on reading comprehension and retelling outcomes of the grade four reading program. Recursive and reciprocal models of the structural equation variety were formulated in order to confirm specified relationships between system components. After coping with multicollinearity in the set of predictor vectors through application of simple ridge regression utilizing the normalization criterion, the findings were interpreted as strongly supporting the psycholinguistic "guessing game" theory of reading comprehension. (Author/DF)

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# CUEING STRATEGIES AND BASIC SKILLS IN EARLY READING*

by

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A paper presented at the International Reading Association Seventh World Congress on Reading, Hamburg, August 2, 1978.

*The study was supported by research grants from Memorial University of Newfoundland and The Canada Council. The authors are grateful for the assistance of W.F. Lee and W. Luk who developed the statistical theory and wrote the computer program for simple ridge regression utilizing the normalization criterion. Our thanks are also extended to four undergraduate students in the first author's 1977-78 primary reading course -- Mary McCarthy, Dianne McKay, Anna-Lise Milford, and Audrey Pike -- who assisted in the coding of the miscue data.

CS004534

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ABSTRACT

The paper addresses the contemporary issue as to the extent to which cueing strategies and basic skills explanations of early reading constitute complementary approaches. Basic skills -- a unidimensional component based on measures of vocabulary development, language skills, and work-study skills -- proved to be a powerful variable mediating the effects of two relatively orthogonal exogenous cueing strategy variables -- graphophonic cues and syntactic-semantic cues -- on reading comprehension and retelling outcomes of the grade four reading program. Recursive and reciprocal models of the structural equation variety are formulated in order to confirm specified relationships between system components. After coping with multicollinearity in the set of predictor vectors through application of simple ridge regression utilizing the normalization criterion, the findings were interpreted as being strongly supportative of the psycholinguistic "guessing game" theory of reading comprehension.

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# CUEING STRATEGIES AND BASIC SKILLS IN EARLY READING

Meeting: Cueing Strategies and Basic Skills in Early Reading
Session Meeting

## Approaches to Early Reading

The traditional focus of theory and research in early reading has been from a basic skills perspective. In the past decade, however, research into the antecedents of reading comprehension by psycholinguists has generated modifications and extensions to the more traditional explanations. This study addresses the question of the extent to which the two approaches--the basic skills approach on the one hand, and the

psycholinguistic approach on the other, are complementary. We examine, therefore, the formal linkages between the two approaches in order to identify the magnitude of their effects as determinants of reading competencies.

Until the end of the 1960s, a basic skills explanation of reading comperhension dominated the early reading literature (see for example Gray and Reese, 1957; Russell, 1961; and Tinker and McCullough, 1962). According to this approach reading is best viewed as a precise process which involves the detailed and sequential perception and identification of letters, words, spelling patterns and larger language units. The notion is consistent with the belief that underlying comprehension in early reading are a number of basic skills such as meaning vocabulary, word recognition, and grammatical usage, that constitute the key ingredients in the effective teaching of reading in the primary grades.

Recent formulations of the early reading process by psycholinguists such as the Goodmans and Carolyn Burke have necessitated revisions to the basic skills explanation. Their meticulous research indicates that reading is actually a selective process, in which the reader uses only part of what is on the printed page, plus whatever he already knows about the structure of the language, together with the background knowledge and experiences which can be marshalled in order to assist in decoding or "figuring out" what is before him. Through the orchestration of these elements the reader arrives at his rendition of what he thinks the author has intended.

Thus, Kenneth Goodman refers to reading as a "psycholinguistic guessing game" involving the simultaneous application of three cueing systems as follows: (a) grapho-phonic information or sound-letter relationships; (b) syntactic or grammatical cues; and (c) semantic or meaning cues. Learning to read requires the application of all three systems; which involves the ability to react to what is read through checking validity, evaluating, making inferences and drawing conclusions. The reader selects as much information from each system as is necessary for him to "guess" or "predict" what is written. If the "guess" does not sound like language, or if it lacks meaning, the reader must discard the "guess" and regress, or go back, for more information--especially grapho-phonic information.

An important contribution of the Goodmans to reading theory has been the development of qualitative miscue analysis. Because the same cues that trigger correct responses also trigger incorrect responses, the Goodmans have been able to examine miscues, or oral reading errors, in order to gain important insights into the reading strategies of young readers.

Because the inferences derived from psycholinguistic arguments regarding the most appropriate strategies for teaching early reading are sometimes at odds with inferences derived from the more orthodox basic skills arguments, there may appear to be a serious "lack of fit" between the two approaches. Thus, although in general, the two complement one another there are differences in emphasis which may vary according to the predilections of the practitioner. In particular the adherents of the basic skills approach may have failed to appreciate the key role of

syntactic and semantic cueing systems in early reading. This is not to say that psycholinguistic insights have been denied by either basic skills formulators or reading teachers. For example, Russell (1961, p. 272) notes that:

> Perhaps more important to teachers than the total number of words a child knows are the amount and kind of meaning he attaches to particular words.

Again, Russell (p. 299-300) points out the use of contextual clues in aiding the reader.

> The phonetic and structural methods of word recognition... become more valuable as they are checked against the meaning of the sentence or paragraph. Similarly, if a difficult word is encountered, the child may make an intelligent guess at it by glancing at the accompanying picture, by using picture clues, or by thinking through what the word is from the meaning of the selection, by using context clues.

In this paper we assess the relative contribution of both psycholinguistic and basic skills explanations of reading comprehension through a systematic and integrated set of analyses based on a single comprehensive data set designed to produce answers to two questions: (i) to what extent are cueing strategies and basic skills explanations of early reading complementary approaches? and (ii) in this context, what are the relative effects of the cueing strategies on reading comprehension while simultaneously considering the effects of the basic skills? A secondary purpose of this research is to help popularize the work of the Goodman group.

## Conceptual Models

### A Basic Skills Model

Before the turn of the present decade, descriptions of the processes underlying the successful acquisition of reading competency

were dominated by "basic skills" explanations. David H. Russell (1961) exemplified this approach and suggested that there are various developmental phases in learning to read. In the primary grades the chief aims of reading instruction are to expand meaning vocabularies and to develop abilities in identifying new words and recognizing familiar and partly-known words; that is, the child must know the meaning of many words and he must be able to "attack" the verbal symbols of unfamiliar sight words so that he can pronounce them correctly and associate them with the appropriate meaning. The methods of attack which have been emphasized are picture aids, sight words, word patterns or configuration, familiar parts of words, compounds of known parts, phonetic analysis, structural analysis and to a lesser extent context clues. The assumption has been that once the reader could identify the word and associate meaning with it, he would be able to comprehend what he read because reading was viewed as essentially a process of getting meaning from printed symbols.

Typically, then, reading is viewed as a precise process. Research into the process has tended to stress the areas of visual perception (Geyer, 1970), grapheme-phoneme relationships to reading (Venezky, 1967; Chall, 1967; Bond and Dykstra, 1967), cues used to identify sight words (Marchbanks & Levin, 1965; Timko, 1970; Williams, Blumberg, & Williams, 1970), and the effects of non-Standard English usage in reading acquisition (Laffey & Shuy, 1973). Such emphases were congruemt with the notions that underlying the complexities of the reading act are a number of identifiable elements known as "basic skills" which constitute the key ingredient in effectively teaching

children to read.

The problem is that the "basic skills" cannot be directly observed. What can be observed are a sample of the values reflected by the unobserved construct, "basic skills". Even though we cannot observe the values of the variable we can observe their underlying sub- and sub-sub-skill components. Russell (1961), for example, identifies three basic sub-skill areas; namely, vocabulary development (1961, chapter 9), word recognition (1961, chapter 10), and work-study skills (1961, chapter 11). Likewise, Tinker and McCullough (1975) continue to consider acquiring concepts and building vocabulary (chapter 7), word identification and recognition (chapter 8), and study skills (chapter 10) as core ingredients in acquiring reading ability. Even more recently, Durkin (1978) considers whole-word methodology (chapter 8), using contexts for help with word identification (chapter 9), phonics (chapters 11 & 12), word meanings (chapter 14), and study skills (chapter 17) as basic instructional areas for teaching children to read.

Each of these sub-skills may be further sub-divided into even more precise sub-sub-skills. For example, the vocabulary development area might be observed in terms of a reader's sight vocabulary and meaning vocabulary. Similarly, Russell's "word recognition" may be sub-divided into such skill areas as spelling, punctuation, capitalization, and language usage. Spelling strategies depend in turn on structural analysis and phonics. Finally, the work-study skills are reflected in students' competencies, at appropriate grade levels, in the interpretation of maps and graphs and the utilization of references. This ordering of the observed and unobserved component skills is shown

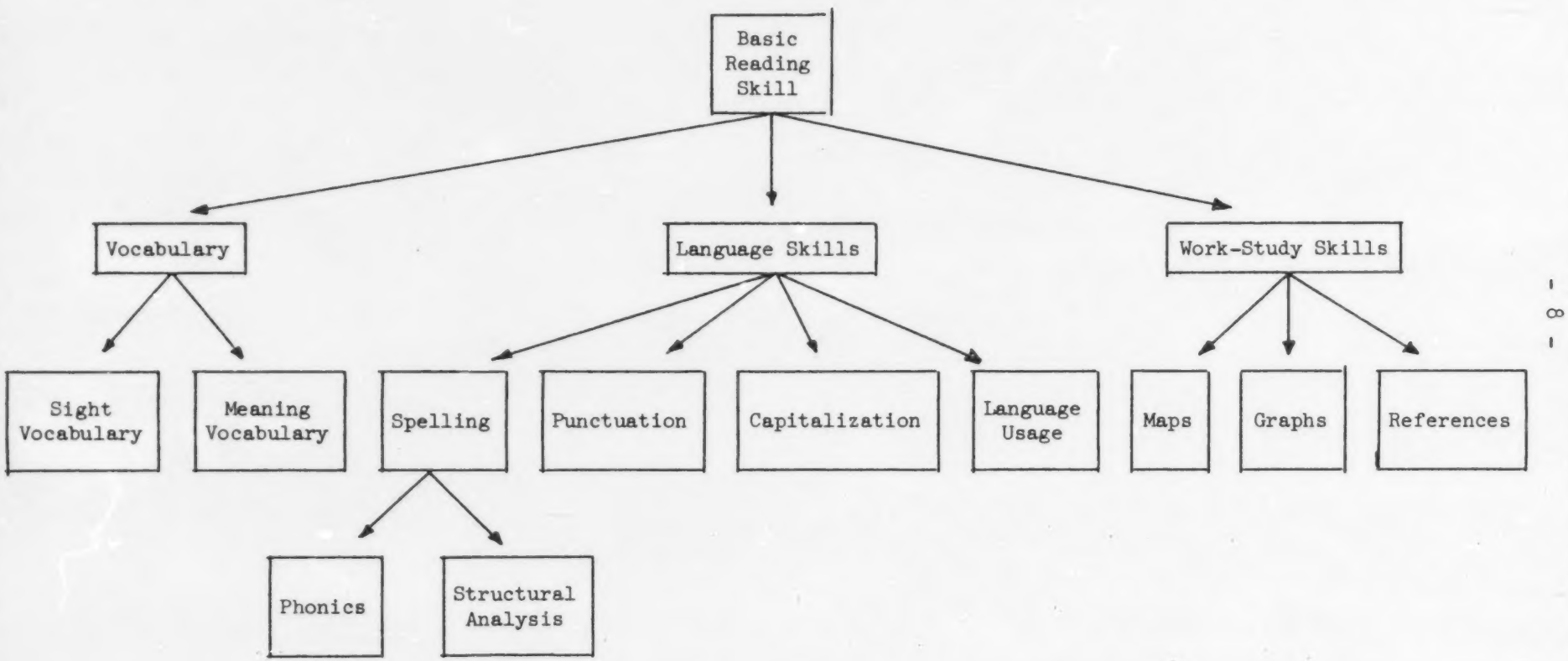
schematically in Figure 1.

Figure 1 About Here

The Cueing Strategy Model

In recent years, reading research has witnessed notable changes in both methodology, with an emphasis on constructing models of reading (cf. Davis, 1971), and theory, with an emphasis on the syntactic and semantic components of reading being considered as the basis of comprehension (Carroll, 1970, 1971; Goodman, 1969, 1970, 1972; and Smith, 1971, 1973, 1977, 1978). Investigators have shifted their research emphases from reading primarily conceived of as a series of careful visual perceptions with research focusing on grapho-phonic skill, to reading as a highly complex multifactor and integrated process. Huey (1980) and Thorndike (1917), noted exceptions to early investigators, generated the interrelated and complex concepts of reading that have formed the basis for much of the research and theorizing that has occurred within the last ten years. For example, Kolers (1970), when analysing the errors of adult readers, found that the visual components of reading had been overstressed at the expense of syntactic and semantic considerations. Supporting Kolers' findings are Hochberg (1970) and Hochberg and Brooks (1970) who suggest that by syntactic and semantic knowledge and periphereal vision, a skilled reader fixates only on those parts of the visual array that he anticipates will enable him to check his guesses about what is being said. This in turn will help him formulate further anticipations. The better

FIGURE 1. Schematic Diagram of the Structure of Basic Reading Skills



the reader, the larger the fixation unit from which he samples the text, and the more likely that words will be decoded by the rapid and easily apprehended features of that word.

Goodman, R.L. Thorndike (1974), Carroll, and Smith have all supported these ideas and readily subscribe to Edward Thorndike's view of the reading process.

> Reading is a very elaborate procedure, involving a weighing of each of many elements in a sentence, their organization in the proper relations one to another, the selection of certain of their connotations and the rejection of others, and the cooperation of many forces to determine final responses. In fact . . . the act of answering simple questions about a simple paragraph . . . includes all the features characteristic of typical reasoning. (1917:323)

Robert L. Thorndike (1974) has pursued the concept of "reading as reasoning" and posits that once basic decoding skills are mastered; that is, when the student has successfully switched from "learning to read" to "reading to learn", performance in reading indicates the thinking and reasoning level of the reader and may, therefore, be a powerful predictor of academic performance. Reading, then, becomes a process that must involve some depth of understanding beyond word meaning. A transformation of visual input, by interaction with the reader's existing knowledge occurs and is generated as comprehension (Goodman, 1965). It has long been recognized that every reader brings to a reading situation a variety of experiences, background, and language knowledge which enables him to react to printed material in logical and well-informed ways which constitute "thinking" and "reasoning" (Carroll, 1970). As the reader encounters printed material in this manner, he performs a highly complex and integrated skill.

Researchers and practioners agree that errors made by readers are indicators of reading performance. Thus for several years, oral reading errors have been subjected to analysis. Rosemary Weber (1968) has reviewed more than thirty studies based on such data and has classified the research into two groups with two distinct concerns. One group was concerned with establishing norms for diagnosing reading weaknesses in order to provide starting points for remedial instruction. This group generally viewed errors as signs of imperfect learning in problem readers. The other group analyzed errors in an attempt to provide insight into the nature of the reading process. Rather than prejudging errors as "undesirable", they used them as (mis)cues for diagnosing and delineating those decoding strategies used by successful readers when deriving meaning from print. Most of these studies, however, focus on words or letters or both, and exhibited a notable lack of concern for the linguistic function of errors by disregarding how closely an unexpected response resembled an expected response.

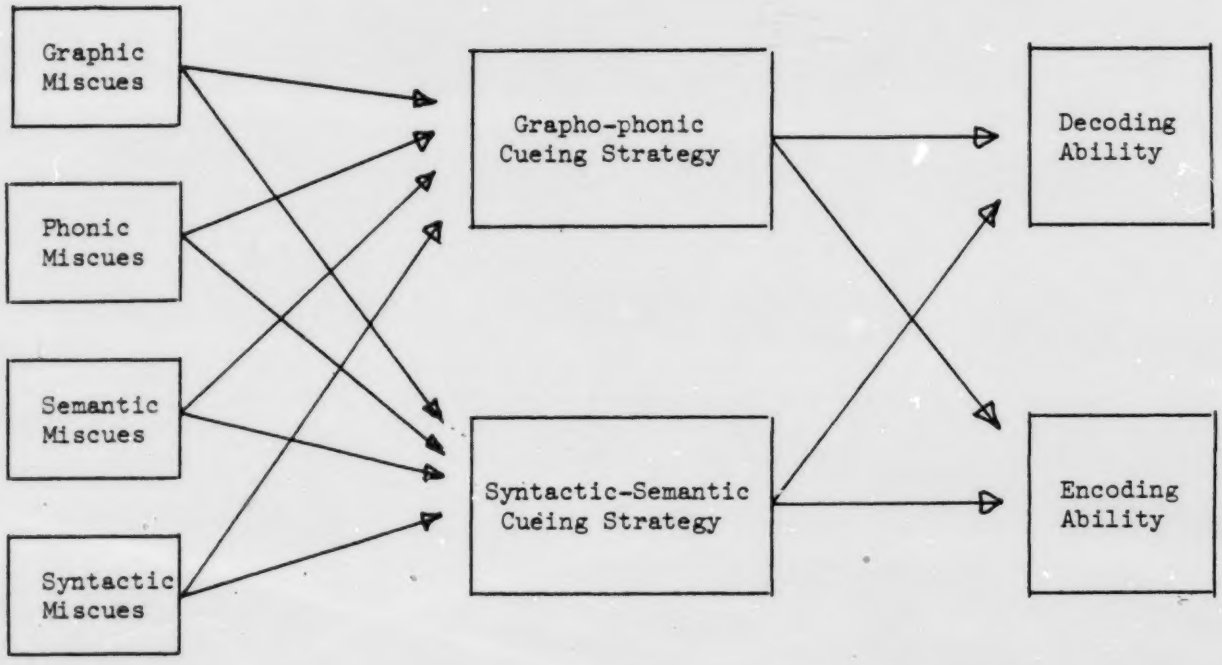
Since 1964 the studies conducted under the direction of Kenneth S. Goodman, in close association with Yetta Goodman and Carolyn Burke, have examined the nature of reading as a psycholinguistic process by focusing on the study of language (linguistics) and the study of learning a language (psychology). The Goodman-Goodman-Burke research has been reported in many papers (Goodman 1965, 1967, 1969; Goodman and Burke 1969; Goodman 1970; and Goodman and Burke 1970), in project reports (Goodman 1968; Goodman and Burke 1969; and Goodman 1971), and in articles in books (Goodman 1970, 1972, 1973, 1976; and Goodman and Niles 1970). Their reading theory in which reading is referred to as "a psycholinguistic

guessing game" incorporates linguistic and psychological principles based upon observed reading behavior (Goodman 1967). The observations are based on their development of a taxonomy of reading cues and miscues (Goodman and Burke 1970) which makes the indepth analysis of oral reading strategies and techniques possible. The resultant miscue analysis provides insight into the degree of interplay of grapho-phonic, syntactic, and semantic information exhibited by the child in decoding graphic display into meaning, followed by its subsequent encoding into spoken language (Allen & Watson, eds., 1976).

Thus, reading comprehension was seen as a function of the simultaneous application of these cueing strategies. The derivation of meaning, then, from printed sources involved the processing of (a) graphic cues, (b) phonetic cues, (c) syntactic or grammatical cues, (d) semantic or meaning cues, and (e) their respective interaction. Though the Goodmans posit the existence of an overall cueing strategy (eg. Goodman and Burke, 1972) which is a function of these four cueing systems, in the research reported here we believe it important to distinguish between two independent strategies--the grapho-phonic and the syntactic-semantic--in order that their relative effects on both decoding and encoding outcomes of the reading process may be estimated. A schematic diagram illustrative of the structure of grapho-phonic and syntactic-semantic cueing strategies and their relationships to decoding and encoding abilities is presented in Figure 2.

Figure 2 About Here

FIGURE 2. Schematic Diagram of the Structure of Cueing Strategies and Their Relationship to Decoding and Encoding Abilities



The Integrated Model

The relationships between basic skills and cueing strategies are based on the notion that cueing systems are primary; that is, that the syntactic and semantic elements of language are already well developed prior to children entering school. Oracy, is achieved naturally in all human societies, and infants regardless of culture follow similar acquisition strategies (Scribner and Cole, 1973) which are characterized by the sequential internalization of syntactic structures. These notions have prompted the authors to argue elsewhere that the grapho-phonic skills taught by the reading teacher, plus the within-class development of the child's syntactic structures and semantic codes constitute the primary verbal reasoning processes (Bulcock and Beebe, 1976; Bulcock et al., 1977; and Fägerlind et al., 1978). The acquisition of oral language makes the sharing of thoughts, needs, problems and feelings possible since it is through language that the user's capacity to conceptualize, remember, generalize, infer, reason, and evaluate is developed.

Thus, it is the development of these strategies through the encouragement of what Goodman (1976) refers to as "risk-taking, meaning seeking, and hypothesis testing" which facilitates the ability to react to what is read through checking validity, evaluating, making inferences, and drawing conclusions, or what E.L. Thorndike (1917) referred to as "reading as reasoning". If the notion that cueing strategies are primary resources is accepted; that is, that they are logically prior and necessary to the development of secondary resources such as reading comprehension, then four propositions follow: (i) that children's primary

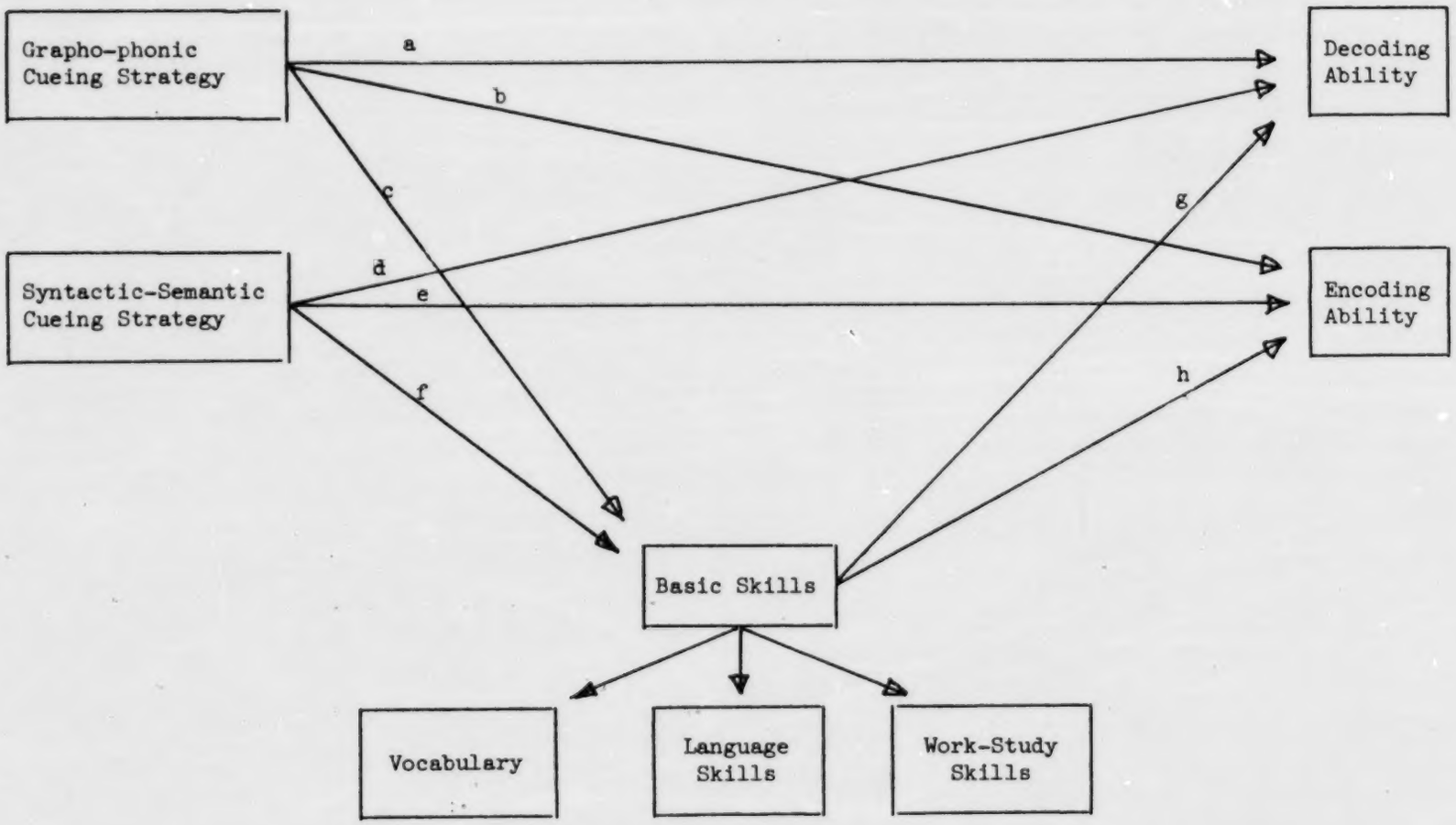
resources in terms of linguistic skills will be already inequitably distributed by the time children begin school; (ii) that school classrooms constitute the major treatment settings where these primary assets are translated into reading competencies which constitute in turn additional desired resources; (iii) that these assets in the form of "reading as reasoning" are important secondary resources which (in conjunction with the primary resources) constitute major common causes of multiple subject-matter achievements in the content fields of schooling; and (iv) that basic skills considerations constitute key linkages in the process of converting primary resources into secondary resources. It also follows that inequalities in the distribution of linguistic resources will be translated into inequalities in the distribution of reading resources in egalitarian school systems; that is, in systems where curricular time allotments are equitably distributed regardless of aptitude (cf. Bloom, 1973).

Thus, the basic skills model may be seen as mediating the linkages between the cueing strategies as the primary resource assets of children and their decoding and encoding abilities as depicted schematically in Figure 3.[1]

Figure 3 About Here

1. Decoding and reading comprehension are terms used synonymously throughout this paper. More precisely, reading comprehension is seen as a proxy variable for decoding. In the generic sense decoding refers to the translation of a message from one code into another. In the case of reading comprehension as a proxy variable we are referring to the individual's perception or understanding of written messages (sic language). In the same way "encoding" and "retelling" are used synonymously; where encoding - transmitting a message from one party to a third party - is the generic term, and retelling a proxy variable referring to the oral interpretation of written language.

FIGURE 3. Schematic Diagram of the Integrated Model



We have specified a two-stage conceptual model for estimating the antecedents of two co-related outcomes of schooling in the early grades--decoding and encoding abilities--which correspond closely to what we have referred to as the students' secondary intellectual resources. The exogenous variables--grapho-phonic and syntactic-semantic cueing strategies--differ from the Goodman-Burke (1972) overall cueing strategy variable in that we believe the observable cueing sub-systems--graphic, phonic, syntactic and semantic miscues--are two dimensional structures, not uni-dimensional. There are also important practical considerations for distinguishing between grapho-phonic and syntactic-semantic cueing strategies. These relate to the relative importance of each strategy in terms of both basic skill development and the development of decoding and encoding abilities.

It is hypothesized that these linkages between the inequities of primary resource development and the disproportionately greater inequities in secondary resource development are mediated by developmental processes in the basic skills. The observable sub-skills underlying the latent construct "basic skills" have been restricted to three indicators in the interests of parsimony (Figure 3). Thus, we have specified the relationships not only between the two cueing strategies and the three sub-skills of vocabulary development, language skills, and work study skills, but also between the two cueing strategies and decoding/encoding abilities via basic skills. In this way it becomes possible, for example, to consider both the direct effects of the grapho-phonic cueing strategy on decoding (path "a" in Figure 3) and the indirect effects attributable to the fact that the grapho-phonic

cueing strategy accounts for variability in decoding because it affects basic skills and basic skills in turn affects decoding (path "c-g", in Figure 3). Similarly, we are able to examine the total effects of the syntactic-semantic cueing strategy on decoding as a function of the direct effects (path "d") and indirect effects (path "f-g").

The second stage of the conceptual model introduces a uni-dimensional basic skills variable which, like the exogenous variables, is a latent construct. In itself the relationship between basic skills and reading is non-problematic since it is well established through educational practice and is perhaps the most widely studied association in the reading research literature. Our model, however, provides for independent estimates of this relationship controlling for the effects of the cueing systems as antecedents. For this reason we will be interested in noting the extent to which the effects of cueing strategies might attenuate the impact of basic skills. Thus, the relationship has potentially profound implications for the teaching of reading.

Finally, we are concerned with the extent to which cueing strategies and basic skills account for the covariation between the two different coding outcomes. One of the most practical questions of the present study concerns the extent that the covariation between different outcomes of schooling in the early grades is accountable to a set of common causes. By ascertaining what these common causes are as well as the relative magnitude of each, net of other causes, it becomes possible to design an early reading curriculum which maximizes goal attainments through emphasizing appropriate strategies for attaining the desired reading outcomes. Since the common elements in the integrated model are

policy manageable--that is, under the control of classroom teachers, particularly the reading teacher--we entertain the thought that teachers may be in greater control of their service to clients than generally believed.

## Data, Variables, and Methods

Data. The analysis is based on data obtained from 94 grade four pupils enrolled in two St. John's, Newfoundland elementary schools. In the Fall of 1975 the first author selected all the pupils in the four grade four classrooms who were able to read a selected passage, but not well enough to avoid making reading miscues. For this purpose the Maze 5 and Maze 6 of the Guthrie-Siefert Maze Task -- a modification of the cloze procedure -- was administered to all the pupils. Maze 5 corresponds to a grade 4.5 reading level and Maze 6 corresponds to a grade 5.2 level. Each test contains 28 items. The cut-off point for inclusion in the sample was 40 points out of a possible total of 56. This meant that those selected were comprehending at least 70 percent of what they read and should, therefore, be capable of reading the passage contained in the study instrument. Details concerning the reliability and validity of the Maze tests which correlate at the 0.82 level with the Gates-MacGinitie Comprehension Test are available in Guthrie (1973).

Cueing Strategy Variables. The cueing strategy instrument used was developed by Yetta Goodman and Carolyn Burke (1972). The procedures for gathering and coding the data were identical to those recommended in their Reading Miscue Inventory (RMI).

For the purposes of the present analysis, however, the measures of the four cueing strategy variables departed in minor ways from the orthodox procedures used for conducting qualitative miscue analyses. Consider, for example, the coding of graphic similarities between the observed response and the expected response. Following Goodman and Burke (1972, pp. 53-55) the authors classified each single word or non-word substitution into one of three categories--highly similar, partially similar, and dissimilar. But unlike Goodman and Burke, who then calculate response percentages for each category, the authors used only one category "the dissimilarities category" for calculating the proportion of miscues lacking graphic similarity. Thus, in this study the graphic miscues variable shown in Figure 2 represents a proportionate measure of each respondent's miscues which lacked graphic similarity. The proportion was obtained by dividing the number of dissimilar responses by the total number of responses in all three categories; that is, by the total number of single word or non-word substitutions.

Note, then, that the graphic component of the cueing strategy variables is not scored such that the higher the score the greater the graphic competency but, rather, the other way round. Miscues are dissimilar from expected responses and the scoring system preserves this feature of the cueing strategies.

The logic of the scoring procedure used in the case of the graphic miscues variable was also followed in constructing the phonic miscues variable, which in this study is referred to as the proportion of miscues lacking phonic similarity.

In the case of semantic and syntactic miscues the authors again

departed in minor ways from the orthodox Goodman-Burke (1972, pp. 59-63) procedure. Only "syntactic weaknesses" were used in calculating an individual's unacceptable syntactic miscues. Similarly, only "comprehension loss" responses were used in calculating an indivudal's unacceptable semantic miscues. Both unacceptable syntactic and semantic miscues were converted into proportions as follows: the unacceptable miscues in each instance were divided by the student's total number of miscues minus the student's number of corrections. The corrections were subtracted because automatically on the correction of a miscue, it becomes acceptable, and congruent with the text, hence the possibility of its unacceptability becomes redundant. We refer to these variables as the proportion of unacceptable syntactic miscues and the proportion of unacceptable semantic miscues respectively.

We emphasize that the syntactic and semantic miscues are not scored such that the higher the score the better the syntactic or semantic strategy. Rather, they are scored such that their hypothesized relationship with reading will be negative; hence, the greater the proportion of unacceptable syntactic miscues the lower the reading comprehension score.

Two latent constructs (factors) were derived from the observable cueing strategy variables--grapho-phonic cues and syntactic-semantic cues--with eigenvalues of 1.734, and 1.083 respectively. The first explained 61.6 percent of the variance, the second 38.4 percent. The factor loading and factor score coefficients for the cueing strategy variables are depicted in Table 1.

Table 1 About Here

TABLE 1. Factor Analysis of the Items Composing the Grapho-Phonic and Syntactic-Semantic Cueing Strategies

| Items | Grapho-phonic | | Syntactic-Semantic | | $h^2$ |
|---|---|---|---|---|---|
| | Loadings on Principal Factor #1 | Factor Score | Loadings on Principal Factor #2 | Factor Score | |
| $X_1$ graphic miscues | .885 | .361 | .120 | -.071 | .798 |
| $X_2$ phonic miscues | .916 | .629 | .200 | .049 | .878 |
| $X_3$ semantic miscues | -.322 | -.028 | .681 | .470 | .567 |
| $X_4$ syntactic miscues | -.094 | .011 | .751 | .491 | .573 |
| Eigenvalue | 1.734 | | 1.082 | | |
| Omega reliability | .918 | | .723 | | |

Variable identifications are: $X_1$ proportion of miscues lacking graphic similarity, $X_2$ proportion of miscues lacking phonic similarity, $X_3$ proportion of unacceptable semantic miscues, $X_4$ proportion of unacceptable syntactic miscues.

Basic Skills Variables. The conceptual model (Figure 3) specifies basic skills as a mediating variable which we constructed on the basis of three indicators. In 1975 the grade four children in the sample were routinely administered a test battery known as the Canadian Tests of Basic Skills (CTBS) (King et.al. 1967). The tests are designed to provide information on the progress of students in vocabulary development, reading comprehension, the mechanics of written expression, and the application of special reading techniques. The assumption is that these are the (basic) skills which determine the extent to which individuals will profit from the level of instruction at the next higher grade level. The CTBS battery is composed of eleven separate tests for each of grades three through eight. Eight of the grade four tests were used in this study for constructing the basic skills composite variable; namely, (1) vocabulary, (2) spelling, (3) capitalization, (4) punctuation, (5) usage, (6) map reading, (7) reading graphs and tables, and (8) knowledge and use of reference materials. Items 2 through 5 were collapsed to form a single language skills variable and the items 6 through 8 were collapsed to form the work-study skills.

The vocabulary test of 38 items took 17 minutes to administer. It emphasized the meaning of words, the use of phonetics and context clues involved in work recognition, and sensitivity to fine shades of meaning through the selection of the most appropriate words in a given context. The language skills test was composed of four sub-tests containing 146 items. The tests took 67 minutes to administer. Work-study skills--a battery of three tests--consisted of 108 items which took 80 minutes to administer. The basic skills variable was also a latent

construct with an eigenvalue of 1.98. The loadings and factor scores for this unidimensional variable are presented in Table 2.

Table 2 About Here

Outcome Variables. The proxy for decoding ability was the CTBS reading comprehension score. King et. al. (1967, p. 30) describe the reading comprehension test in the following terms--"The skills tested ... may be classed under four headings: details, purpose, organization, and evaluation. Because of the close correlation between test performance on items of these four types, it is not considered worthwhile to derive a separate score for each." There were 70 items on the reading comprehension test which took 55 minutes to administer.

Encoding was measured by the RMI retelling score calculated for each subject. Immediately following the oral reading the child retold as much of the story as he could remember in his own words. A series of questions was then asked by the first author in an attempt to stimulate further recall and interpretation (Beebe 1976, p. 44). The total score of 100 percent was made up of four components with varying weights; character analysis - 30%, events - 45%, plot - 15%, and theme - 10%. By allocating points in this manner, subjects could score above 50% by simply recalling facts from the story. To obtain a high score, however, they must also have inferred relationships and evaluated the significance of story events. Since this aspect of the measurement was to some extent dependent on the researcher's subjective opinion of how completely each subject had described each recall component, and since four coders trained by the first author assisted in the research, a random selection of the

TABLE 2. Factor Analysis of the Items Composing the Basic Skill Variable

| | Items | Principal Component Loadings | Factor Score | $h^2$ |
|---|---|---|---|---|
| $X_7$ | Vocabulary | .518 | .331 | .646 |
| $X_8$ | Language | .543 | .392 | .692 |
| $X_9$ | Work-Study | .516 | .327 | .643 |
| | Eigenvalue | 1.981 | | |
| | Omega reliability | .854 | | |

tapes were checked for coding accuracy. The retelling scores for five subjects were rescored and a correlation coefficient between the two sets of scores of .99 revealed the consistency in the allocation of points.

Methods. The matrix of correlations (Table 3) for all observed and unobserved variables was the basis for the subsequent factor analyses and regression analyses using ordinary least squares procedures. Following Van de Geer (1971, p. 132, formula 13.13, and p. 135, formula 13.15) factor score coefficients were used as path weights in inward indicator reflective models and factor loadings as path weights in outward indicator models. The distinction between unobserved variables in reflective models whose observables appear as outward indicators of the latent construct (for example, the "basic skills" variable) and unobserved variables specified in such a way that the observables appear as inward indicators of the latent construct (for example, the grapho-phonic and syntactic-semantic cueing strategies) is an important one in this paper. Omega reliabilities (Heise and Bohrnstedt, 1970, p. 115) were calculated for all latent variables.[2]

Table 3 About Here

2. Omega reliability = $1 - \frac{W'(I - H^2)W}{W'RW}$, where

W = the weight matrix of the composite score; R = the correlation matrix; and $H^2$ = the communality matrix. See Tables 1, 2, and 3 for relevant data. The computing formula was derived as follows:

$$\rho ss' = \frac{W'RW + W'H^2W - W'IW}{W'RW} = 1 - \frac{W'IW - W'H^2W}{W'RW} = 1 - \frac{W'(I - H^2)W}{W'RW}$$

TABLE 3. Zero-Order Correlations, Means, Standard Deviations, and Case Base of Variables in the Integrated Model of Cueing Strategies and Basic Skills in Early Reading

| Variables [a] | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $X_8$ | $X_9$ | $X_{10}$ | $X_{11}$ | $X_{12}$ | $\bar{X}$ | SD | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $X_1$ PCS1 | 1.00 | | ns | ns | | ns | | | | | | ns | 19.53 | 9.66 | 94 |
| $X_2$ PCS2 | .835 | 1.00 | ns | ns | | ns | ns | | | | ns | ns | 22.00 | 10.20 | 94 |
| $X_3$ PCS3 | -.198 | -.163 | 1.00 | | | | | | | | | | 36.10 | 19.12 | 94 |
| $X_4$ PCS4 | .002 | .069 | .542 | 1.00 | ns | | | | | | | | 33.40 | 13.66 | 94 |
| $X_5$ GP | .931 | .977 | -.206 | .039 | 1.00 | ns | | | | | | ns | 0.0 | 0.96 | 94 |
| $X_6$ SS | -.166 | -.084 | .910 | .838 | -.137 | 1.00 | | | | | | | 0.0 | 0.74 | 94 |
| $X_7$ VOCAB | .287 | .206 | -.550 | -.360 | .257 | -.544 | 1.00 | | | | | | 46.90 | 9.18 | 85 |
| $X_8$ LAN | .315 | .276 | -.538 | -.385 | .313 | -.549 | .669 | 1.00 | | | | | 47.15 | 9.07 | 85 |
| $X_9$ WORK | .260 | .251 | -.498 | -.316 | .276 | -.482 | .644 | .667 | 1.00 | | | | 45.15 | 8.19 | 87 |
| $X_{10}$ SKILL | .334 | .283 | -.597 | -.394 | .327 | -.594 | .875 | .897 | .866 | 1.00 | | | 0.03 | 0.92 | 83 |
| $X_{11}$ RDGCOMP | .271 | .204 | -.552 | -.351 | .250 | -.543 | .730 | .633 | .773 | .806 | 1.00 | | 45.5 | 9.27 | 84 |
| $X_{12}$ RETELL | .141 | .097 | -.515 | -.337 | .129 | -.500 | .544 | .353 | .407 | .475 | .494 | 1.00 | 44.6 | 17.6 | 94 |

[a] PCS1 = proportion of miscues lacking graphic similarity; PCS2 = proportion of miscues lacking phonetic similarity; PCS3 = proportion of unacceptable semantic miscues; PCS4 = proportion of unacceptable syntactic miscues; GP = grapho-phonic cueing strategy; SS = syntactic-semantic cueing strategy; VOCAB = vocabulary; LAN = language skill; WORK = work-study skills; SKILL = basic skills; RDGCOMP = reading comprehension; RETELL = retelling score. Coefficients GT 0.21 are significant at the $p < .05$ level; ns = not significant.

## Findings

### The Causal Structure of the Antecedents to Basic Skills

The structural parameters of the entire model are based on the matrix of coefficients shown in Table 3 above. These are presented for a recursive model in Table 4.

Table 4 About Here

Our interest centers first on the cueing strategies/basic skills relationships which are illustrated in Figure 4. It is noted that reading miscues were of four kinds which formed two logically distinct orthogonal factors--grapho-phonic miscues ($X_5$) and syntactic-semantic miscues ($X_6$). The direct effects of these two cueing strategies on basic skills ($X_{10}$) is both statistically and substantively significant.

Figure 4 About Here

The coefficient of -.560 for the effect of syntactic-semantic cueing strategy on basic skills is not problematic. As predicted by the theory the greater the student's syntactical-semantic deficiency the lower the student's competency in the basic skills. The magnitude of the coefficient is unusually high, demonstrating the importance of the relationship. It effectively means that students deficient in this linguistic resource will likely experience difficulty in mastering the basic reading skills. The amelioration of these resource deficiencies deserves a high priority on the primary school program.

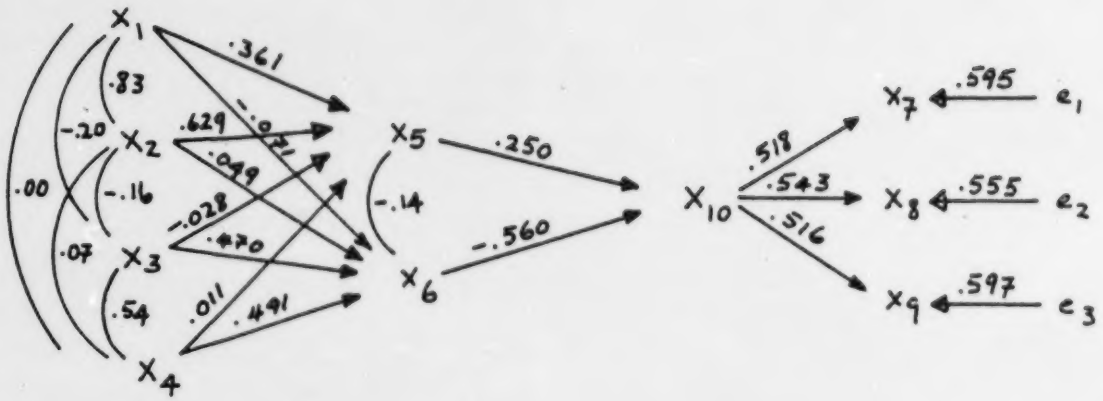
The positive effect of the grapho-phonic cueing strategy on basic skills is a more problematic relationship to explain. In the literal

TABLE 4. Regression Coefficients (B), Path Coefficients (P), Standard Errors B (in parenthesis) and R Squares for Variables at Each Stage of the Integrated Model

| | Dependent Variables | | | | | |
|---|---|---|---|---|---|---|
| | $X_{10}$ | | $X_{11}$ | | $X_{12}$ | |
| Variables[a] | B | P | B | P | B | P |
| $X_5$ GP | .241 (.083) | .250* | -.080 (.678) | -.008 | -.145 (1.837) | -.008 |
| $X_6$ SS | -.700 (.108) | -.560* | -1.241 (1.034) | -.099 | -8.016 (2.799) | -.336* |
| $X_{10}$ SKILL | | | 7.524 (.866) | .750* | 5.287 (2.345) | .277* |
| Constant | .028 | | 45.303 | | 44.502 | |
| $R^2$ | | .415 | | .656 | | .299 |

*The relationship is defined as statistically significant when the absolute value of B is at least twice the standard error of B. [a]$X_5$ grapho-phonic cueing strategy; $X_6$ reading comprehension; $X_{12}$ retelling score.

FIGURE 4. Path Model of the Relationships Between Cueing Strategies and Basic Skills

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Variable identifications are: $X_1$ proportion of miscues lacking graphic similarity; $X_2$ proportion of miscues lacking phonetic similarity; $X_3$ proportion of unacceptable semantic miscues; $X_4$ proportion of unacceptable syntactic miscues; $X_5$ graphophonic cueing strategy; $X_6$ syntactic-semantic cueing strategy; $X_{10}$ basic skill; $X_7$ vocabulary development; $X_8$ language skill; $X_9$ work-study skill.

sense it means that those grade four readers who make the highest grapho-phonic scores--that is, those who have the highest proportion of miscues lacking graphic and phonic similarity--will have the greatest competencies in the basic skills. Though this relationship does not seem to make sense in that it is illogical to believe that those who make the most mistakes will be the most proficient, it is consistent with "guessing game" theory.

The relationship should not be taken literally. The typical grade four reader will be entering that phase of reading development which Gray (1956) identified as "learning to use reading as a tool". It is the stage of "reading to learn" as opposed to the emphases in earlier stages on "learning to read". By this stage the pupil will have command over a large sight vocabulary: thus, most common words will be instantly recognized. Similarly, the typical grade four reader will be skilled in the recognition of letter-sound relationships and in the use of context clues as aids in pronunciation and meaning as a direct function of the teaching of the phonetic and structural analysis of words. In short, the basic skills will probably be well-developed. The skilled grade four reader will have learned--albeit imperfectly at first--to follow a sequence of ideas and their relationships, possibly for several pages at a time.

Success, then, in the use of reading as a tool requires an important--even radical--change in earlier emphases. Increasingly the student's ability to comprehend involves the making of inferences, the evaluation of ideas, and the detection of bias. Such emphases are dependent on the student's willingness to take risks in the search for

meaning. The effective teacher will encourage those explorations which are paradigmatic of hypothesis testing, and in so doing will probably demand that the reader go beyond his immediate experience level. Success in these ventures may be measured by the extent to which the pupil's reading assumes a vicarious dimension--an indicator of imaginative reading. The constraints of time and place will be broken and precocious readers may begin to develop interests in other peoples, other places, and different time periods.

Some pupils will be reluctant to take risks. They will need encouragement to "guess again" before they can be expected to make the quantum leap from learning to read to reading to learn. What about the grade four reader who does not make the transition? Such pupils will be dependent on their grapho-phonic strategies and, consequently, are likely to be less successful than their more adventurous peers in following an idea or narrative extemporaneously for several pages at a time. The odds are that though they will be able to give a precise rendition of a passage, they will still be unable to take the basic skills for granted. It follows, therefore, that grade four readers still dependent on grapho-phonic cueing strategies will have the smallest proportion of miscues lacking graphic and phonic similarity and at one and the same time have the lowest competencies in the basic skills. It is this positive association which we find between $X_5$ and $X_6$ in Figure 4, and why it indicates support for the "guessing game" thesis.

The question arises as to whether the cueing strategies have different effects on the sub-skill components of basic skills; namely, vocabulary development, language usage, and work-study skills. These

effects are shown in the upper-half of Table 5 and the results are

Table 5 About Here

consistent with our earlier findings. The effect of the grapho-phonic strategy on each sub-skill is positive and of equal magnitude (about 0.13); and the effect of the syntactic-semantic strategy is negative and over twice as powerful (about 0.29 in each case).

These relationships can be disaggregated further as shown in the lower-half of Table 5. Here the effects of each cueing strategy on each sub-skill are shown. Again the effects are in the direction hypothesized by the psycholinguistic theory, and the semantic and syntactic cueing strategies are more powerful than the grapho-phonic. The results underscore the importance of developing competencies in the syntactic-semantic cueing strategy insofar as the basic skills performances of grade four pupils are concerned.

Common Causes of the Covariation Between Reading Comprehension and Retelling

The effects of basic skills on both reading comprehension and retelling while taking into account the effects of the two cueing strategies are shown in Table 4. The relationship is central to the integrated model because its magnitude determines the extent to which cueing strategies and basic skills explanations of early reading are complementary approaches. Since it is easier to picture the realignment of theory and data in the form of a path diagram we present integrated model relationships in Figure 5. Model estimation also enables us to address the question as to the

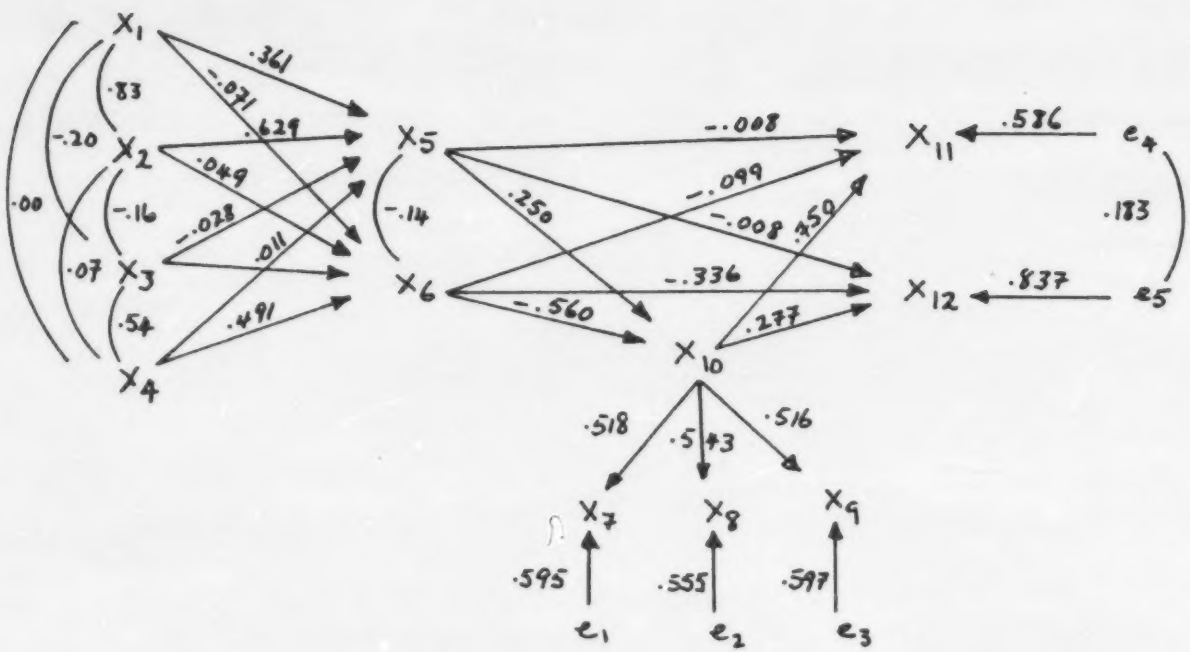
Figure 5 About Here

TABLE 5. The Indirect Effects of Cueing Strategies on Vocabulary Development, Language Skills, and Work-Study Skills

| Independent Variables | Indirect Effects on $X_7$ | Indirect Effects on $X_8$ | Indirect Effects on $X_9$ |
|---|---|---|---|
| $X_5$ GA | .129 | .136 | .129 |
| $X_6$ SS | -.290 | -.304 | -.289 |
| $X_1$ Graphic | .068 | .071 | .067 |
| $X_2$ Phonic | .067 | .070 | .067 |
| $X_3$ Semantic | -.136 | -.143 | -.136 |
| $X_4$ Syntactic | -.142 | -.149 | -.142 |

Variable identifications are: $X_1$ proportion of miscues lacking graphic similarity, $X_2$ proportion of miscues lacking phonetic similarity, $X_3$ proportion of unacceptable semantic miscues, $X_4$ proportion of unacceptable syntactic miscues, $X_5$ grapho-phonic cueing strategy, $X_6$ syntactic-semantic cueing strategy, $X_7$ vocabulary development, $X_8$ language skills, $X_9$ work-study skill.

FIGURE 5. Path Diagram of the Integrated Model of Cueing Strategies and Basic Skills in Early Reading




Variable identifications are: $X_1$ proportion miscues lacking graphic similarity, $X_2$ proportion miscues lacking phonetic similarity, $X_3$ proportion unacceptable semantic miscues, $X_4$ proportion unacceptable syntactic miscues, $X_5$ graphophonic cueing strategy, $X_6$ syntactic-semantic cueing strategy, $X_7$ vocabulary development, $X_8$ language skills, $X_9$ work-study skills, $X_{10}$ basic skills, $X_{11}$ reading comprehension, $X_{12}$ retelling score, e, to $e_5$ - unmeasured determinants of $X_7$ to $X_{12}$ respectively.

extent to which the covariation between reading comprehension and retelling is accountable to a limited set of common causes. Since the common causes in the model are policy manageable it becomes possible to determine the extent to which decoding and encoding abilities are under reading teacher control.

We take-up the reading comprehension outcome first. It is noted that the path coefficient for the effect of basic skills on reading is a "whopper" ($p_{11,10} = .750$).[3] It is also noted that in the presence of basic skills the direct effects of the two cueing strategies (-.008 and -.099 respectively) are negligible. Neither is statistically significant. In the stage one model (Figure 4), however, it was shown that cueing strategies were determinants of basic skills. Thus, they could have powerful indirect effects on reading comprehension via basic skills despite their negligible direct effects. The results in Table 6 confirm the strong total causal effects of the syntatic-semantic cueing strategy--a result predicted by psycholinguistic guessing game theory--which is almost three times the effect of the grapho-phonic cueing strategy (-0.519 compared to +0.180). Further, because the total grapho-phonic effects are positive their interpretation is logically the same as that provided in the first stage of the model where basic skill was the outcome of interest.

Table 6 About Here

3. In terms of our (Figure 5) model, it may not be too misleading to suggest for the benefit of readers unfamiliar with path coefficients that coefficients of .300 or greater represent strong effects, coefficients between .150 and .300 represent moderate effects, and coefficients less than .150 represent weak effects.

TABLE 6. Indirect, Direct, and Total Causal Effects on Reading Comprehension and Retelling with Basic Reading Skill as an Intervening Variable

| Independent Variables | Determinants of $X_{11}$ | | | Determinants of $X_{12}$ | | |
|---|---|---|---|---|---|---|
| | Indirect through $X_{10}$ | Direct | Total Causal | Indirect through $X_{10}$ | Direct | Total Causal |
| $X_5$ GA | .188 | -.008 | .180 | .069 | -.008 | .061 |
| $X_6$ SS | -.420 | -.099 | -.519 | -.155 | -.336 | -.491 |

Variable identifications are: $X_5$ grapho-phonic cueing strategy; $X_6$ syntactic-semantic cueing strategy; $X_{10}$ basic reading skill; $X_{11}$ reading comprehension; $X_{12}$ retelling score.

We regard this finding as quite profound. For more than a decade linguists have argued that reading involves the simultaneous "taking-in" of patterns and structures of meaning beyond a mere word level (e.g., Lefevre, 1964); that understanding is interfered with if the reader atomizes reading into words, letters, or non-sense syllables; that, therefore, making sense of what is read demands a grasp of the syntax of lines of print. This is not to say that phoneme-grapheme correspondence is unimportant; rather, that grapho-phonic elements are relevant only within the pattern of the complete sentence.

Both Goodman (1970, p. 19) and Smith (1973, p. 82) have argued that the reading process involves decoding surface structure writing (graphic input) into meaning or deep structure (underlying meaning), which is then encoded into surface structure as spoken language (oral output). But the degree of interplay between the graphic, phonic, semantic, and syntactic information exhibited by children in decoding graphic display into meaning, followed by its subsequent encoding into spoken language, has not previously been determined through a systematic and integrated analysis of a single comprehensive data set as represented by Figure 5. Thus, the overwhelming support for the psycholinguistic model in the present analysis is gratifying. It is especially important to note that the cueing strategy effects operate via basic skills; and that, therefore, the cueing strategy and basic skills approaches are complementary and not competing theories.

The findings regarding the retelling outcome are less clearcut for two reasons. First, the explanatory power of the retelling model is less powerful than that of the reading comprehension component. Secondly,

the basic skills variable ($X_{10}$) operates differently for retelling than for reading comprehension with a beta of .277 compared to the effect on reading comprehension of .750 (Figure 5). This probably accounts for the fact that the syntactic-semantic strategy operates directly ($p_{12,6}$ = .336) on retelling. Grapho-phonic effects on retelling as on reading comprehension are negligible both directly and indirectly (cf. Table 6). Since these findings were not anticipated it would seem reasonable to pursue the analysis further. We begin by examining the correlated residuals ($r_{e4,e5}$), Figure 5.

The correlation between reading comprehension and retelling ($r_{11,12}$) is 0.49. But the correlation between the residuals is 0.18 (Figure 5). Since the correlation implied by the measured predictors ($r'_{11,12}$) is 0.311, the combined effects of cueing strategies and basic skills account for (.311/.494) x 100 = 63 per cent of the correlation between the two outcomes. This means that 37 per cent of the common variance in $X_{11}$ and $X_{12}$ is not accounted for by either cueing strategies or basic skills.

The psycholinguists provide the clues. They believe that deep structure is encoded into surface structure again as spoken language; that is, that reading comprehension affects retelling. In terms of schooling, however, both are achievement outcomes and a virtually self-evident educational proposition holds that "achievement stimulates achievement". In other words, the reading comprehension--retelling relationship is reciprocal. This possibility is taken-up next through the formulation and estimation of a reciprocal effects model.

A Reciprocal Effects Model

In this section of the paper we estimate the parameters of the reciprocal effects model. Nonrecursive models which allow for simultaneous or reciprocal causation between endogenous variables have been dealt with extensively in the econometric literature (cf. Goldberger 1964, Theil 1971, or Johnston 1972). For this reason computer programs for economic analysis are especially well-developed. The two-stage least squares (2SLS) solution to the reciprocal effects problem utilized White's (1978) general computer program for econometric methods.

Two caveats are necessary. White's 2SLS program operates on a raw data matrix input, not a correlation matrix. It also lacked missing data options which maximize data utilization. Thus, we had to use a list wise deletion procedure which meant the loss of 11 cases out of the 94 case sample. These were the grade four students who were absent from school when the Canadian Tests of Basic Skills in reading comprehension was administered. Nevertheless, the resultant correlation matrix (Table 7) did not differ appreciably from the original matrix (Table 3). Secondly, primary emphasis on the substantive issues precludes the possibility of attending to some of the interesting methodological issues which are raised in the reciprocal effects analyses.

The matrix of correlations for the observed and unobserved variables in the 83 case data base is presented in Table 7. The weights

Table . About Here

used in latent variable construction were the same as those used in the recursive models; thus, paths on the inward indicators of the cueing

TABLE 7. Zero-Order Correlations, Means, Standard Deviations of Variables in the 2SLS Model

| | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $X_8$ | $X_9$ | $X_{10}$ | $X_{11}$ | $X_{12}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $X_1$ | | | | | | | | | | | | |
| $X_2$ | .820 | | | | | | | | | | | |
| $X_3$ | -.197 | -.174 | | | | | | | | | | |
| $X_4$ | -.003 | .072 | .503 | | | | | | | | | |
| $X_5$ | .925 | .975 | -.214 | .040 | | | | | | | | |
| $X_6$ | -.173 | -.091 | .903 | .822 | -.145 | | | | | | | |
| $X_7$ | .292 | .212 | -.556 | -.363 | .263 | -.553 | | | | | | |
| $X_8$ | .310 | .268 | -.537 | -.383 | .306 | -.549 | .669 | | | | | |
| $X_9$ | .276 | .265 | -.480 | -.285 | .291 | -.461 | .655 | .659 | | | | |
| $X_{10}$ | .334 | .283 | -.597 | -.394 | .327 | -.594 | .875 | .897 | .866 | | | |
| $X_{11}$ | .271 | .205 | -.554 | -.353 | .252 | -.546 | .730 | .633 | .781 | .806 | | |
| $X_{12}$ | .119 | .069 | -.472 | -.275 | .102 | -.448 | -.275 | .340 | .381 | .475 | .496 | |
| $\bar{X}$ | 19.16 | 21.68 | 35.80 | 32.44 | -.03 | -.03 | 46.90 | 47.35 | 45.63 | .03 | 45.47 | 44.81 |
| SD | 9.80 | 10.29 | 18.89 | 13.27 | .96 | .72 | 9.28 | 9.09 | 8.05 | .92 | 9.32 | 17.43 |

strategy variables ($X_5$, $X_6$), and paths on the outward indicators of basic skills ($X_{10}$) remained unchanged from those reported in Figures 4 and 5. The structural parameters for all subsequent reciprocal effects models are based on the Table 7 matrix.

The path diagram showing the 2SLS results is presented in Figure 6. We found these results implausible and unacceptable. The

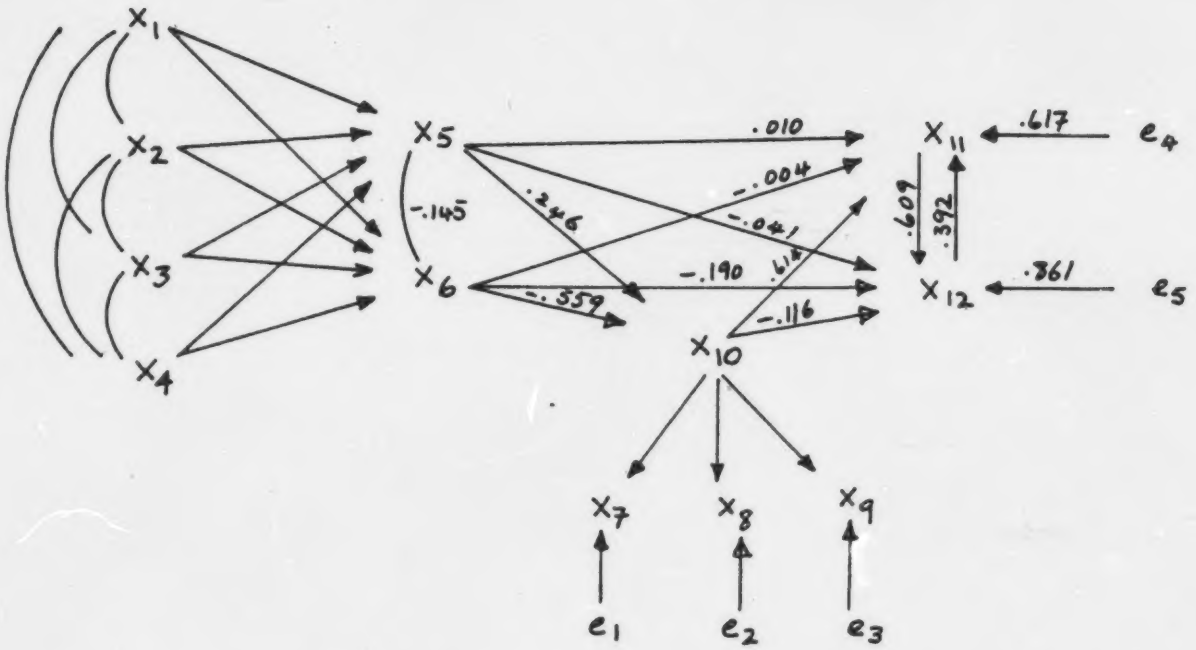
Figure 6 About Here

negative relationship for the effect of basic skills on retelling ($p_{12,10} = -.116$) not only reverses earlier findings but also contravenes both theory and practice. It is necessary, therefore, to consider alternative solutions.

Despite recent advances in the specification of complex models of behaviour--for example, the displacement of asymmetrical models dependent on the partitioning of R square variance, in favour of symmetrical models of the structural equation variety (Duncan, 1975)--model symmetry is seriously jeopardized by the presence of multicollinearity or the condition where predictor vectors depart from orthogonality. The situation is especially problematic in view of the fact that the better the specification in multi-stage models the greater the probability of departure from the condition of linear independence in the second and subsequent stages of a model. And the greater the departure from linear independence the greater the multicollinearity problem. Thus, it is a matter of degree not of kind.

Although the effects of multicollinearity are recognized--for example, (i) the generation of some least squares estimates which are

FIGURE 6. Path Diagram of the Reciprocal Effects Model



inflated in absolute value, (ii) which may have large standard errors, (iii) which in the case of some coefficients may result in the incorrect sign, and (iv) which may be overly sensitive to the fluctuations of data from sample to sample--little, until recently, could be done about it at the analytical phase of research.

We believe that our reciprocal effects model (Figure 6) may suffer from all these problems; that, therefore, it would be valuable to ascertain the severity of the problem. Marquardt and Snee (1975) have argued persuasively that though there are several viable measures of multicollinearity, the best single measure is the maximum variance inflation factor, Vmax. Variance inflation factors (VIF) are the diagonal elements of the inverse of the simple correlation matrix. The VIF of each term constitutes a measure of the collective impact of the interdependency of the explanatory variables on the variance of the regression coefficient of the term. Its value provides a measure of the number of times its variance has been inflated. Unfortunately a maximum VIF score is difficult to interpret in that an absence of collinearity is scored "1" and perfect collinearity is given a score of infinity. Lee (1978) provides a solution by transforming VIF max so that D = 0 represents no collinearity and D = 1 stands for perfect collinearity.[4] D ≤ 0.7 may be considered serious even though in the social sciences collinearity of this magnitude is commonplace.

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4. $D \equiv (2/\pi)\tan^{-1}(Vmax - 1)$; where Vmax is the maximum VIF; $\tan^{-1}(Vmax - 1)$ is measured in radians; and where in factor space $X'X = \Lambda$ and $D \equiv 2/\pi \tan^{-1}(1/\lambda_p - 1)$.

The "D" multicollinearity value for the reading comprehension model of 0.452 was not considered serious. This was not the case for the retelling model, where D = .741; verifying our hunch about the extent of the collinearity problem.

During the present decade it has been shown that ridge regression is theoretically superior to ordinary least squares (OLS) estimates for coping with the problem (e.g., Hoerl and Kennard, 1970a, 1970b, Kasarda and Shih, 1977, and Vinod, 1976). Following the first proponents, Hoerl and Kennard (1970a) all subsequent analysts have used the minimum mean squared error (MSE) criterion rather than the unbiased minimum residual sum of squares criterion called for by the OLS procedure. This is because it has been shown that for any multiple regression problem there is an "optimal k" solution which minimizes total MSE, and which always provides a better estimate than that of OLS. The optimum k solution, however, is a function of two unknowns; hence, can only be estimated. At the last count there were about 15 different ways of estimating k.

There is another problem involved when using the MSE criterion. This stems from the fact that it is an omnibus procedure which performs several functions but need not provide the single best solution to any one function. The fact that different estimating procedures generate different "k" is illustrated in Table 8. Recently Lee (1978) has addressed these problems and developed a new criterion ($k_N$) referred to as the normalization criterion. It was designed to perform a single task; namely, to minimize the harmful effects of multicollinearity. It

Table 8 About Here

TABLE 8. Simple Ridge Augmentation Constants "k" for Different Estimates

| Estimating Procedure | Reading Comprehension Model | Retelling Model |
|---|---|---|
| $k_N$ Normalization (Lee, 1978) | .120 | .152 |
| $k_S$ (Kasarda and Shih, 1977) | .280 | .527 |
| $k_V$ (Vinod, 1976) | .904 | .681 |

has two advantages. First, it can be determined exactly; and, second, it is nonstochastic.

The reciprocal effects model was reanalyzed using the $k_N$ criterion. The structural parameters of the ridge regression analysis are presented in Table 9. Pictorial presentation in Figure 7 follows the conventions of orthodox pathanalysis. Note, however, that the

Table 9 About Here

Figure 7 About Here

path-coefficients are standardized ridge regression coefficients. We interpret these results as being in keeping with our integrated model hypotheses.

The total causal effects (Table 10) also support our earlier

Table 10 About Here

interpretations. Thus, the problems associated with the 2SLS analysis using the residual sum of squares criterion have been satisfactorily resolved through ridge regression utilizing the normalization criterion.

Note, however, the unexpected anomaly. According to psycholinguistic theory graphic input (surface structure writing) is decoded into underlying meaning (deep structure) which in turn, is encoded into oral output (surface structure spoken language). Our assumption throughout has been that reading comprehension constituted a satisfactory proxy for decoding ability and retelling a proxy for encoding ability. We have argued that both, as outcomes of the school reading program, will be

TABLE 9. Regression Coefficients (B), Path Coefficients (P), Standard Errors of B (in parenthesis) and R Squares for Variables at Each Stage of the Reciprocal Effects Ridge Regression Model Utilizing the Normalization Criterion

| | $X_{10}$ | | $X_{11}$ | | $X_{12}$ | |
|---|---|---|---|---|---|---|
| Variables | B | P | B | P | B | P |
| $X_5$ | .236<br>(.083) | .246* | .315<br>(.640) | .033 | -.597<br>(1.538) | -.033 |
| $X_6$ | -.721<br>(.112) | -.559* | -.554<br>(1.027) | -.042 | -4.705<br>(2.291) | -.193 |
| $X_{10}$ | | | 5.079<br>(.828) | .503 | 2.137<br>(1.656) | .113 |
| $X_{11}$ | | | | | .558<br>(.193) | .298 |
| $X_{12}$ | | | .232<br>(.077) | | | |

The levels of significance based on T-ratios and F-tests are not provided here. According to Obenchain (1977) the significance levels for the ridge estimates can be generated in the same way as if OLS procedures were being used. Note, however, that the OLS procedure is unbiased whereas the ridge regression procedure is not. Note, too, that other than Obenchain's work levels of significance for ridge estimates have not been established.

FIGURE 7. Path Diagram of the Ridge Regression Analysis Utilizing the Normalization Criterion for the 2SLS Model

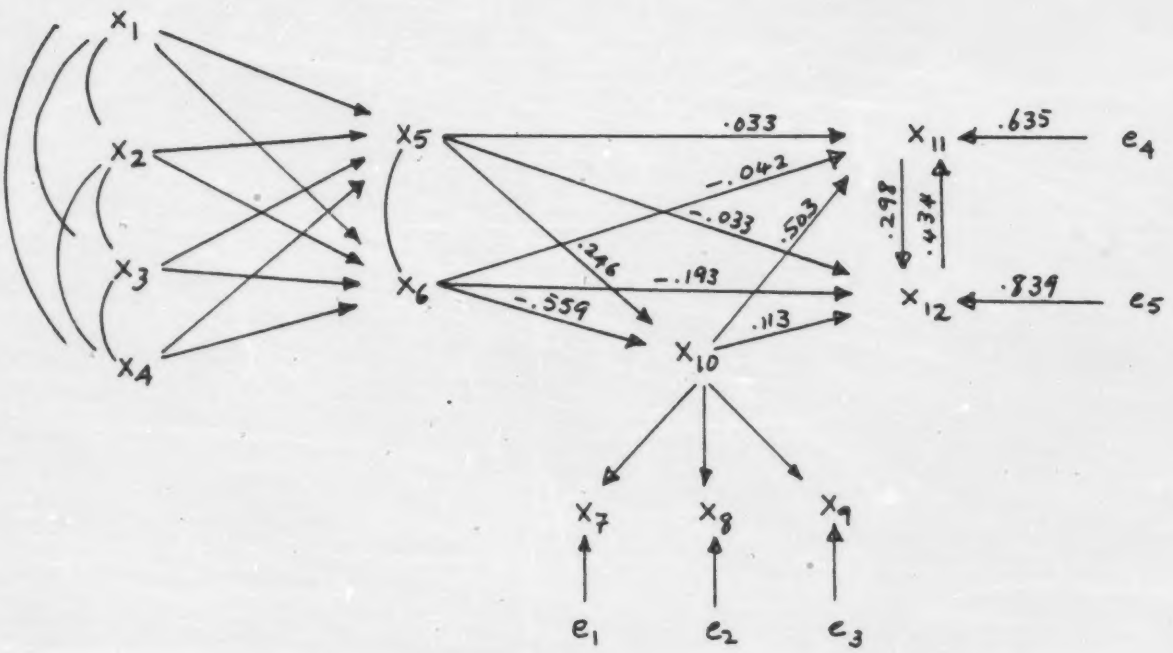

TABLE 10. Indirect, Direct, and Total Causal Effects of Predictors on Reading Comprehension and Retelling in the 2SLS Ridge Regression Model

| Independent Variables | Determinants of $X_{11}$ | | | | Determinants of $X_{12}$ | | | |
|---|---|---|---|---|---|---|---|---|
| | Indirect through $X_{10}$ | Indirect through $X_{12}$ | Direct | Total Causal | Indirect through $X_{10}$ | Indirect through $X_{11}$ | Direct | Total Causal |
| $X_5$ | .124 | -.002 | .033 | .155 | .028 | .046 | -.033 | .041 |
| $X_6$ | -.281 | -.111 | -.042 | -.434 | -.063 | -.076 | -.193 | -.332 |
| $X_7$ | | .049 | .503 | | | .150 | .113 | .263 |

mutually reinforcing such that achievement in one would stimulate achievement in the other, though it was anticipated that the $p_{11,12}$ effects would prove more powerful than $p_{12,11}$ effects. In fact, the opposite is the case. Retelling has a stronger impact on reading comprehension than the other way round.

Though we have no ex-post-facto solution to suggest, it seems that either there is a lack of isomorphism between encoding and its operationalized measure, "retelling", or else the retelling variable is a more complex construct than hitherto believed. For example, it may be operating as something more analogous to verbal development (an important dimension of mental ability) as witness its correlation ($r = .54$) with vocabulary development; or even as a proxy for something more analogous to a pupil's stage of thinking. If this hunch is correct then the model may be seriously misspecified through the mis-ordering of an exogenous variable in the set of structural equations. We suggest, then, that psycholinguists may wish to pay more attention to the measurement of encoding ability, and we appeal for reading research using longitudinal data sets.

## Conclusions

In conclusion we wish to consider the theoretical and practical importance of the study. The two fundamental questions that this study attempted to answer were: (i) to what extent are cueing strategies and basic skills explanations of early reading complementary approaches? and (ii) what are the relative effects of the cueing strategies on reading comprehension while simultaneously considering the effects of the basic

skills? In the findings strong trends emerged which led the investigators to conclude the following.

1. Two logically distinct orthogonal factors emerged as miscue variables; namely, a grapho-phonic variable and a syntactic-semantic variable. This, in effect, meant that graphics and phonics (as measured by the RMI) were so closely related that they were inseparable as distinct entities. Similarly, syntactic and semantic strategies were found to be inseparable (especially since semantics is so dependent upon syntax).

2. The effects of the syntactic-semantic strategy were more powerful (in both the recursive and the reciprocal models) than were the effects of the grapho-phonic strategy. This held true for the effects of the two cueing strategies on basic skills as well as on reading comprehension and retelling ability. The most important feature of this set of relationships is that the effects of these two strategies were the strongest on the basic skills and only exhibited weak direct effects on reading comprehension and retelling scores.

Meanwhile, the effect of basic skills on reading comprehension was strong but on retelling was of more modest proportions. In the recursive model the indirect effects of the syntactic-semantic variable via basic skills and retelling, plus the small amount of direct effect, gave a total causal effect of -.434 as compared to a total causal effect of .155 for the graphic-phonic variable. It appears, then, that the reader's ability to utilize syntactic and semantic structure determined to a greater extent his reading comprehension than did his ability to read precisely and accurately. This, of course, is not to deny the

importance of developing adequate grapho-phonic skills, because letter-sound relationships are a core ingredient in what is recognized as the basic skills. It does, however, help to emphasize the tremendous importance that language facility and background experience play when children are systematically instructed in basic skill areas while learning to read. Further, this finding would seem to imply that children must be taught and encouraged to use both what they know of language plus their background knowledge when reading, rather than concentrating exclusively on accurate and precise word pronouncing. It would seem that the student who is willing when the need arises to "take risks" and "guess" at what is on the printed page, increases his efficiency in utilizing the basic skills while reading. Therefore, it cannot be stressed strongly enough that the syntactic-semantic cueing strategy serves as a base upon which sound basic skills are acquired and developed. To develop a child's language and living experience resources gives that child a multiplicative advantage in acquiring reading ability because these resources operate and multiply when used in conjunction with basic skills acquisition. The acquisition of basic skills in turn, gives the child a tool or a mechanism through which his intuitive grasp of language and understanding can operate.

3. One final tentative conclusion is worth noting. It was pointed out in the findings section that, in both the recursive and the reciprocal models, the path-coefficients for the direct effect of the syntactic-semantic variable on the retelling score was stronger than the direct effect on reading comprehension. It was also pointed out that the retelling variable had a stronger effect on the comprehension

score than the other way round, which was a totally unanticipated occurrence. Further, the correlation between the vocabulary score of the CTBS and the retelling score was .54. These facts would seem to imply that the extent of a child's meaning vocabulary, his utilization of the syntactic-semantic cueing strategy, and his ability to recall, interpret and retell a story are closely related.

The authors believe these relationships imply that those students who had a large meaning vocabulary, (which of course resulted from the advantages of complex and varied language and life experiences) were able to use this prior conceptual knowledge to their advantage when providing a verbal commentary on the passage. The path-coefficient of .434 for $p_{12,11}$ (Figure 7), which indicates the effect of retelling ability on the silent reading comprehension score seems to indicate that those students who effectively utilized the intuitive syntactic-semantic cueing system, interacted with the print in such a way that they were able to predict, confirm, correct and integrate meaning so proficiently that they were capable of retelling the story in a manner that illustrated their understanding of the passage. These integrating abilities, in turn, appeared to affect silent reading in a very positive manner--hence the strong path-coefficient of .434 and the suggestion that the retelling score is a better indicator of the child's thinking, reasoning and verbal fluency than of his recall of the story.

All of this only underscores the impact of language and life experience learning (both first hand and vicariously) on reading comprehension. This, in turn, suggests the possibility of increasing reading ability through the use of teacher designed strategy lessons

such as those suggested by Goodman and Burke in the RMI manual or by Watson (1973) which focuses on developing a child's ability to "guess" of "predict" appropriate substitutions for problematic words.

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